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EDITORIAL

THE COLLEGE OF AGRICULTURE AS A FACTOR IN THE CAMPAIGN FOR GREATER PRODUCTION

It is gratifying to see our legislature take up economic problems with a seeming zest and determination which has never before been witnessed. We venture to fortell that results will be forthcoming, quickly and abundantly, but, like most measures intended for quick results, they are merely palliative; they are the result of the enthusiasm of the moment, rather than those of a self-energizing measure built on a solid foundation, and which gives results as a matter of necessity. While emergency measures have their place, yet the wise legislator cannot afford to neglect real constructive legislation. Everybody realizes the importance of increased production, a few recognize the value of training the farmer; but very few realize that knowledge and teachers are necessary for the training of the farmer.

The motive which is back of the establishment of the College of Agriculture is to train students to become good farmers. Very often, the remark is made to a young man desiring to take the agricultural course that he does not need a college training for that kind of life, and that his father's farm would make a more appropriate training ground. This is indeed true, if the boy is expected to farm as did his father, grandfather, and great-grandfather. But conditions of life have changed since his ancestors' methods of farming were appropriate, and while they are simple and reliable, yet are lacking in effectiveness to keep pace with the higher cost of living that has come about the last decade and a half. The new farmer must produce more and better crops to meet the demands of the market, and thus insure for himself a good living. It is the aim of the college to teach its students *how* to solve these problems.

At this moment's writing, the college has sent more than eighty graduates and hundreds of young men who had one or more years of training in agriculture. These are scattered all over the Islands in various capacities; as teachers, investigators, farm managers, and actual farmers. The criticism has often been made that most of our graduates seek employment. It is easy to see why

it is so; firstly, because the greater demand is for teachers to disseminate knowledge, and hence comparatively high salaries are paid to men in these positions. If a graduate figures that when employed he can make more money than when working alone, it is but wise that he prefer employment. There is no doubt that the community or the country as a whole will derive greater good from a graduate who is engaged in improving the methods of farming of the locality than if he were doing his work alone and keeping his knowledge and training for getting good returns all to himself. A condition will undoubtedly obtain in time when it will be as profitable to be employed as not, or when salaried positions become so scarce that only a few can be accommodated. Secondly, the majority of our students are not of the wealthy class, and, when graduated, they do not usually possess enough capital to start by themselves and, of necessity, have to seek employment. These students generally plan to engage in individual farming as soon as they have saved enough to make a profitable start. While thus engaged, they accomplish a second purpose; that of widening their experience by coming in touch with a more mature mind, their chief. And last, but not least, some students attend the college already with the purpose of teaching after graduation, as that is the calling that appeals to them most. One thing that cannot be denied is that in whatever employment our graduates may be found they do their best in fulfilling their mission, the betterment of Philippine agriculture.

Beyond the training of students, the college has made a study of all conceivable Philippine crops. Most of this, of course, has been preliminary in nature, to discover just which cultures are most promising. In a large number of cases, the evidence has been conclusive enough to be put into practice. No details will be enumerated here, and the interested reader is referred to the report of the Dean on *The Work of the College of Agriculture* in THE PHILIPPINE AGRICULTURIST AND FORESTER, Vol. V, No. 1 (May, 1916), where the several projects are taken up in detail. This work would continue at double speed if we had the means to do it. With animals, our work has been limited by our equipment, but enough has been found out in hogs and poultry to determine our future lines of activity.

Such is in brief the work of the College of Agriculture. We are extremely fortunate in being able to profit ourselves from the experience of other nations, and to use a vast amount of knowledge they have acquired through patient work and large expenditures of money. Whatever ideas they have, however, have to be revised in their application to Philippine conditions. Ours being a different country altogether, we face different crops, weather conditions, labor etc., and in short, different problems. All of these facts operate in modifying results. We cannot rely blindly, then, on the success of others, and there is nothing left to us but to solve our own problems. The Islands are sorely in need of this kind of work, and the quicker it is done, the better. The College of Agriculture, realizing this situation, undertook the investigation of Philippine crops and the adaptability of foreign crops to local conditions without any special funds for the purpose. The work has necessarily been limited, by the means and equipment at our disposal. But whatever was done has been absorbed by our student body, and not made use of solely by the individual experimenter.

An experiment station has long been recognized as an indispensable adjunct of a college of agriculture, and our own

college here offers a most fertile spot on which to place one. Without experimentation, we would have in the faculty only a set of phonographs, more or less eloquent in repeating what others have said; the machine on the market would, perhaps, do better and cheaper work. While it is a necessity to know what others have found out, yet a teacher should employ part of his time in seeking new truths and thus relieve himself from the dangers of mental stagnation. It is the confidence in one's self, acquired through personal acquaintance with facts, that instills life into the words of an instructor which in turn reflects as enthusiasm in his students; after all, what makes an institution great, if not the work of its faculty.

With the establishment of an experiment station at the college, results are instantly in the hands of students, and these, coming from all parts of the Islands, form an invaluable and economical nucleus for the dissemination of agricultural facts.

If the college should stop short after the training of students, it would not be serving all the purposes which it is capable of serving. The government is entrusted with the responsibility of developing the natural resources of the country, and to create a college of agriculture to train a handful of students as a means of furthering this work is a slow process. It could well be entrusted with the work of taking to the busy farmers who cannot come to college the knowledge it is gleaning and thus enlarge its sphere of action and usefulness. That this arrangement is highly desirable can be judged by the way American colleges of agriculture are adopting it. At present, there are very few agricultural colleges in the United States and Canada which do not maintain an extension department.

We have succeeded in bridging our greater problem when we started; to attract students to a profession which was considered degraded for three long centuries. We want to have many more students, but, with our present means, would be unable to handle them, and those we have now are by no means adequately provided; we have outgrown our equipment three to five years. Anybody interested in the material development of the Islands will readily see that any setback made on the agencies at work at present will mean that much less in effect in years to come.

—B. M. Gonzalez, '13.

The Dairy Industry in the Philippines and its Possibilities

By Leopoldo Guillermo Mendoza

Thesis presented for graduation from the College of Agriculture, No 83

HISTORY OF THE INDUSTRY IN THE ISLANDS PREVIOUS TO THE AMERICAN OCCUPATION

Dairying in the Philippines dates as far back as the early days of the Spanish conquest, when tame carabaos were introduced from China. Prior to this period there were found in the Islands "many buffaloes, called carabaos, which were raised in the fields and were spirited"; the tame animals appear to have been imported in large numbers to be "used only for milking" purposes. Carabao's milk gained favor among the natives because it "is thicker and more palatable than that of the cow." (1) This preference led to the carabao becoming the milk animal rather than the cow, and later, cattle came to be used principally for meat purposes. Manuel Buzeta, in his *Diccionario Geográfico-Estadístico-Histórico de las Islas Filipinas*, published in 1850, states that cattle in large numbers were shipped to the markets of Manila from different parts of the Islands.

However, cows were used to some extent for milk; definite mention is made of a rich Spaniard who, bequeathed his herd of cattle to the Royal Spanish Hospital in order to provide the patients of the institution with an adequate milk supply. (2) Father Juan de la Concepcion relates that, about 1608, some friars petitioned the government that the natives of the town of Pila be given permission to use the land in the *sitio* of Jalajala for a cattle range, so that cattle might be brought in to provide milk for the poor patients confined in the hospital. (3) The opportunities then, during the early days of Spanish rule, for the carabao and the cow as a dairy animal were about the same since cattle were brought in from Mexico as early as 1589 and Chinese cattle much earlier perhaps. (4) The native dairy business during the last fifty years of the Spanish régime was the natural outgrowth of the dairying of long before. It is a pity that no books were written on the subject nor records kept describing the methods and systems of management followed in the earlier period.

Among the natives the business was not conducted in a regular manner on a sound business basis due to the lack of an adequate knowledge of the subject. Everything was handled in a haphazard way and consequently no one ever prospered in the business. Besides the unprofitableness of the business which affected the owners, another phase of the industry, both detrimental and condemnatory, concerned the consumers; they received the product in a condition unfit for human food. This was due to "the improper care of vessels and receptacles in which the milk was kept, the practice of adding river or estero water, and the failure to take the necessary precautions to keep the milk fresh. There was also the contamination at the time of milking to be reckoned with. The carabao is by nature a very dirty animal and doubtlessly contributed a full share to the sum of impurities that vitiated the milk." (5)

The carabaos for dairying were practically never selected, or set aside for the purpose, and likewise there was no particular set of persons that took up the business in earnest. Families or individuals, who happened to own ani-

mals, usually sold milk as the animals bore young. The dairy cows were as badly chosen. There was no such thing as a dairy type in either the cow or the carabao. The same disregard and indifference shown in the choosing of suitable animals was practiced in care and feeding. During the planting and harvesting season, the carabaos were either used in the field or tied or let loose along the river banks away from the cultivated areas; at other seasons they were allowed the freedom of the fields. At all times, however, the animals were gathered in corrals at night. The cows received nearly the same treatment. During the dry weather the carabaos were allowed to wallow either in rivers or in mudpools.

Milking was done early in the morning. At milking time, the calf was tied near its mother and sometimes allowed to draw a little milk from each teat to start the flow. The milk was drawn into a glass or a bottle until the milk in the udder was completely exhausted. Then the mother and the young were released and sent to the field. The calf was permitted to run with its mother almost all the time.

The Spanish government seems to have given very little or no sanitary supervision over the dairy business, so, in the majority of cases, milk sold in the market was very much adulterated by the vendors. The marketing of this product, however, was done only during the last two decades of the Spanish régime, and then was confined to large towns and cities. The quantity marketed was not very great, since carabaos at that time were widespread. So a large portion of the native population, having their own animals, did not have to depend on the market for their milk supply. Rinderpest at this time was an unknown disease in the Islands.

When dairying was taken up more seriously by some who looked upon the business as a means of support, they managed in the course of time to produce fresh carabao cheese of inferior quality. This product was well received by the public. The output was meager, since no one dared go into the business on a large scale. The handling of the cheese was similar to that of the milk. Carabao cheese has become an article of commerce in a number of provinces, notably so in Laguna. (6)

THE DAIRY INDUSTRY OF TODAY

Throughout the Philippines buffalo cows are kept on farms remote from markets, principally for their calves. The milk is used locally and is merely an incidental product. But there are farms that are organized for dairy business; this is particularly true of those farms which are located near a large market for milk.

The native dairy farms are run almost always on a small scale; perhaps the largest number of milch carabaos in any is four or five and in a majority of cases only one or two. The distribution of these farms is most irregular: a rather large number of them may be found bunched very near each other in a locality or district, or near the outskirts of a big town or city where there is a large milk demand, while other farms are sparsely scattered in barrios at some considerable distance from the town. Some of these dairymen supply one or two town dealers who in turn send the milk to the city for sale or to supply another city dealer, while others get contracts to supply milk peddlers.

Carabaos are largely used for milk purposes although there are farms which make use of the cow. The latter animal is not much favored, however, because it cannot be used for field work. The carabao is usually a draft and a milk animal at the same time. There are

very few instances where the cow is used in the field. Dairy carabaos when used in the field are not, as a rule, given full work. They are made to work only in the morning.

Selection, if at all observed, is based on the size of the animal and the development of both the udder and teats. Frequently, an animal bearing young is used freely and is milked as long as it gives milk. Mating takes place any time and without discrimination, as the dairy animal is let loose with the rest of the herd. Carabaos may be found milked as young as two years or as old as sixteen. The price per head varies in different localities, a fair average price being between ₱100 and ₱150.

There is much to be desired by way of improvement in the native method of milking. The operation is almost always performed under insanitary conditions. The only cleaning that the owner does is to wash off the lower extremities and wipe the udder with a moist cloth or rag. This partial cleaning is seldom done. The calf is allowed to suck for a few minutes to start the flow of the milk, then the milker begins the operation with his hand and continues drawing the milk until all the milk in the udder has been completely extracted. During the first two months that the animal is milked, some milk is left in the udder for the calf. After the morning milking is completed, both the mother and the young are let loose in the field until five in the evening, when they are caught and the calf is separated or muzzled with a triangular device which keeps it from sucking. The calf is allowed to go with its mother unrestricted all day when the latter shows an abundance of milk, otherwise, when the calf begins to eat grass, its feeding is regulated. When the surrounding lands are cultivated, animals are always kept in confinement and green fodder provided for feed.

The amount of milk collected varies with different animals. Some give as low as 0.3 of a liter, while others give as much as 7 liters, or more. The age of the carabao and the calf, and the number of times it has borne young is said to affect considerably the secretion of milk. The owner of a farm in Caloocan gives the following figures from experience:

QUANTITY OF MILK COLLECTED DAILY

Condition of the carabao	*Approximate amount daily*	
1st calving	2 chupas	
2nd "	4 "	
3rd "	6 "	
4th "	4 "	
5th "	3 "	1 chupa—0.375 liter

It is estimated that at the third calving the dairy carabao is between 5 and 6 years old and this age is generally considered the time in which the animal is at its best. Cases have been found, however, where dairy animals give as much as 7 and 8 chupas of milk a day, especially during the rainy season. The farmer quoted above gives the following facts in connection with the age of the calf:

Between the ages of 2 and 5 months of the calf, 4 chupas of milk daily may be easily collected from its mother.

Between the ages of 6 and 7 months of the calf, 2 chupas daily.

At the age of 8 months, only one chupa.

Milk is never drawn for the market until the calf is one month old. In some localities two or three months are allowed to pass, because the milk collected during this time is thin and not desired by the consumers. The dairy carabao usually gives milk continuously for one year, or more.

In the city of Manila there are a number of small dairy farms which use the so-called Australian cows; these are imported from Australia, and are probably Shorthorn, Ayrshire and Holstein grades in varying proportions. These dairy establishments are owned and managed by Spaniards. They have from 5 to 10 or more cows, and, although there are no adequate quarters made for the purpose, the animals are very much better off both as to care and feed, than any of the best cared-for native dairy animals. The price per head varies from ₱300 to ₱500. We find in these dairy farms the same negligence in the selection of the cow as the native dairy men. Cows are bought with only the recommendations of being young, of having good size, of bringing a calf and of being milkable. Hence, cows may be found in the farm, which give as low as 4 liters and as high as 15 liters of milk a day. These animals are bred regularly, using either native or imported Australian bulls. The calves are sold as they attain the age of from 3 to 4 months, and when the milk animals come to an age when the milk supply diminishes, they are sent to the butcher. Therefore, new animals are bought whenever the milk supply of the farm is low. Newly imported dairy cows appear to be in perfect condition but they deteriorate in the course of time so the dairymen are obliged to constantly renew their stock. The climate of the Philippines does not seem to suit these imported cows.

In one of these establishments cows are bred, three months after parturition or after five to six months if the animals do not come in heat then. Milk is collected for market up to the sixth month of the cow's pregnancy. At other farms milk is drawn continuously or until the animals go dry. The milking is done by hand twice daily. Marketable milk is collected twenty to twenty-five days after the birth of the calf.

The cows are bathed and kept well groomed every day and some owners give their animals two hours daily exercise in the yard. In milking, the udders are disinfected and washed with hot water, and the milker's hands are also cleaned in the same manner. The calf is tied in front of the mother while milking is in progress to insure the quietness of the latter. The receptacle used for the milk is a bucket in some farms and a porcelain vessel in others. The calf is allowed to remain with the mother all the time. Generally, the same milkers are made to milk the same cows every time. These imported cows sometimes give milk continuously for one year. The dairymen agree in the opinion that the best quantity and quality of milk is collected from animals that are from 4 to 7 years old. The average amount of milk these establishments get from a cow is from 10 to 12 liters a day. The price of milk delivered at homes is ₱0.50 a liter.

The feed of the dairy animals consists of imported crushed food,* corn, and, rice bran. Six gantas (1 ganta = 3 liters) of a mixture of the above feeds constitute the daily ration given in two portions in some farms and three in others. In the former case the first portion is given at seven in the morning and the second at five in the evening, while in the latter a portion is given morning, noon and evening.

The Spanish establishments, being located in the city, are under strict sanitary supervision by the Bureau of Health. Milk samples are taken every now and then for examination and the animals are properly inspected so that the milk sold in the market is almost always good and wholesome.

* Crushed food is usually made of a mixture of ground oats, barley, corn, wheat, cowpeas and wheat bran.

The provincial dairymen are not under sanitary supervision in their municipalities, so they feel free to follow whatever method they like. It is only the farmer who brings his product to the city who is made to conform strictly with the city sanitary regulations. This new order of things, however, came into existence only eight or nine years ago. In the city of Manila, up to 1906, the milk business, especially that conducted by the native dealers, was no better regulated and supervised than in the provinces. As a rule, the milk offered for sale in the city market came from the surrounding provincial towns and hence, because of the improper handling of vessels and animals, and the insanitary surroundings when milking, the product was generally unwholesome and filthy. This condition of things was further aggravated by the usual method of wholesale adulteration of milk. To put a stop to these things "an active campaign was inaugurated by the Bureau of Health for securing better milk for the people of Manila; of 213 samples taken by its agents and examined at the Bureau of Science, only 131 were found fairly good. Small dealers in many instances frankly admitted that they added water, coconut oil, rice flour, sugar or other substances in order to cheapen the price at which they could sell their milk." The result of this campaign of the Bureau of Health was the passing, by the municipal board, of an ordinance regulating dairies and dairy products.

"This sanitary code of Manila makes ample provisions for the sanitary maintenance of dairies and for the inspection and examination of dairy products. It prohibits persons suffering from contagious, infectious, or communicable diseases from working in dairies or assisting in the production, distribution, or storage of dairy products and specifies that all tables, receptacles, and utensils used in the dairies shall be maintained at all times in a cleanly condition and free from all noxious matter. The surface of the interior walls and ceilings of the rooms of every building used for this purpose shall be limewashed or otherwise covered during the months of January and July of each year, and the woodwork frequently and thoroughly scrubbed.

It is now unlawful to bring into the city or to sell or to offer for sale any milk that is not fresh and wholesome, or that has been watered, adulterated, reduced, or changed, in any respect, by the addition of water or any other substance or by the removal of the cream; however, milk from which any part of the cream has been removed may be offered for sale or sold if the fact is publicly advertised on the cart or in the place of business of the vendor or made known to the purchaser at the time of the sale. Adulterated milk is held to include (*a*) milk containing more that 12% of milk solids, including fats; (*b*) milk containing more than 88% of water or fluids; (*c*) milk containing less than 3% of fats; (*d*) milk drawn from animals within 15 days before or 5 days after parturition; (*e*) milk drawn from animals fed on any substance in a state of fermentation or putrefaction or any unwholesome food, like *digman;* (*f*) milk drawn from cows in a diseased or unhealthy condition, or from cows kept in a crowded or unsuitable place; (*g*) milk from which any part of the cream has been removed, and (*h*) milk to which has been added water or any foreign substance whatever.

In order further to protect the milk supply, it is provided that any person or persons owning or having in their possession, or being in charge of milk or dairy animals, the milk of which is to be sold in the city of Manila, shall cause animals to be subjected to the tuberculin test, to determine the

presence of tuberculosis prior to offering such milk for sale or use in the city of Manila."(7)

The carabao milk is used almost wholly by the native population. In some instances, notably in some towns of the province of Laguna, a large per cent of the milk produced is made into some kind of cottage cheese. The market price of carabao milk adulterated to twice its volume with water is twenty centavos per chupa, while the pure product brings 33 centavos per liter or 10 centavos a chupa when bought in the farm. To constant patrons the "baptized" or watered milk is sold by street peddlers at ₱0.125 a chupa. Laguna cheese sells, 3 cakes 3″×2″×½″, for ₱0.50 and the Caloocan cheese, circular and a little larger than a peso, ¼″ thick, at ₱0.03 a piece.

POSSIBILITIES OF THE CARABAO AS A DAIRY ANIMAL IN THE PHILIPPINES

Carabao milk is the principal native dairy product in the Islands and its consumption is apparently limited to the native inhabitants. The foreign population having hastily formed an unfavorable opinion of this milk, "the question of securing fresh dairy products" has become therefore "a most important one for the comfort of the foreign residents" here, since "the best breeds of milk cattle, like Jersey, Guernseys, and Holsteins, when introduced into the tropics very quickly degenerate. They are not suited to its climate and cannot be easily acclimatized. They soon grow thin and sickly, cease giving large quantities of milk, and die." If this "unthinking prejudice" which the foreign population have against the carabao milk were put aside, the supply of fresh dairy products which they greatly need, could be secured because a milk strain of this animal may be easily developed through proper and systematic selection or through the importation of Indian, or perhaps Chinese, carabaos. "There is a race of water buffaloes which come from Delhi, India, that gives over thirty pounds of milk per day, and this buffalo milk is so rich in fat that 12 to 13 pounds of it make a pound of butter." (9) Mr. C. O. Levine of the Canton Christian College, China, in a private letter states that in "a special study of the carabao from a dairy standpoint and after running butter fat tests on the nine dairy carabaos of the college for several months" he has secured an average test of 13.6% and he believes that this figure is higher than that of any official test of carabao milk, so he thinks that in that part of China, they must have a distinct type of high testing animals. He further states that one buffalo cow has given him an average test for two months of 16.8% butter fat.

The native carabaos used as milk animals in the Philippines have been found to be quite variable in their milk yield and butter fat content.

Analyses were made of carabao milk in the College of Agriculture chemical laboratory. The butter fat content was determined by means of the Babcock test using 17.6 cc. of milk. Total nitrogen was determined by Gunning's official method and the per cent of nitrogen obtained was multiplied by 6.38 to get the nitrogen compounds of the milk. Ash was determined by the official method for the analysis of dairy products. Both the nitrogen and ash determinations are described in Bulletin 107, revised, of the Bureau of Chemistry, U. S. Department of Agriculture. Casein was estimated by Hart's method described in Tottingham and Peterson's *A Laboratory Manual of General Agricultural Chemistry*. Milk sugar or lactose was found by the polariscopic method

described in Sherman's *Organic Analysis*, revised edition, page 361. The determination of total solids, not fat, was made by calculation.

TABLE I—ANALYSIS OF CARABAO MILK

	1	2	3	4	5	6	7	8	9	10	Ave.
Age of carabao years.....	7	4	3	7	16	13	5	6	15	6	
Age of calf months.....	5	3	5	5	4	3	5	4	3	3	
Type of animal Type of feed	*heavy grass*	*medium grass*	*heavy corn suckers hay*	*medium cane tops grass*	*heavy grass*	*medium cane tops, hay*	*heavy cane tops, hay*	*heavy grass*	*medium grass*	*heavy cane tops, grass*	
Specific gravity.	1.034	1.039	1.026	1.032	1.040	1.034	1.041	1.029	1.043	1.031	1.0349
Fat.....	5.25	8.10	6.55	12.90	5.95	7.85	6.60	5.10	6.00	4.10	6.84
Protein.....	4.66	5.52	4.91	5.83	4.91	4.51	4.35	4.72	4.82	5.41	4.97
Casein.....	4.30	5.04	4.00	5.40	4.50	4.00	4.00	4.30	4.10	4.90	4.45
Lactose.....	4.61	5.20	5.40	4.60	5.21	5.10	5.32	4.85	5.83	5.45	5.16
Ash.....	.90	.79	.89	.91	.61	.83	.85	.77	.86	.80	.83
Solids, not fat.	10.17	11.51	11.20	11.37	10.73	10.40	10.52	10.34	11.51	11.66	10.95

Among the native dairy carabaos which subsist mostly on grasses, individual animals may be found that give from 7 to 8 liters of milk a day and, with proper care and intelligent feeding, this quantity can be considerably increased. The Indian dairy carabao especially that of Delhi gives as much as 30 pounds of milk daily. (12) The thirty-five analyses presented above give an average of 9.27% of fat. This figure means that for every 10 to 11 pounds of milk there could be made a pound of butter. The Indian buffalo cow gives a pound of butter for every 12 to 13 pounds of milk and the Chinese buffalo cow, basing calculations on the figures given by C. O. Levine, gives the same proportion of butter to milk. The carabao then gives promise of becoming a milk producer for butter making.

The butter imported into the Philippines, from 1912 to 1914 inclusive, or for a period of three years, amounted to ₱1,474,230, or a yearly average of ₱491,410. The oleomargarine or imitation butter that was consumed here in 1913 and 1914 was worth ₱116, 118. (12) David G. Fairchild says: "as regards the quality of the butter made from buffaloes' milk I can judge from its general use in the Bombay presidency that it is in no way really objectionable, though its white color is not so attractive nor its aroma as full as that of Danish butter." (13) So far as the color is concerned, this can easily be remedied by the addition of the usual *anatto*,* and the aroma can probably be improved through better feeding and better control of starters.

NOTES ON THE DAIRY INDUSTRY OF OTHER TROPICAL COUNTRIES

The general condition of the dairy industry in India and the West Indies is, according to the information we have been able to secure, both primitive and unsatisfactory, and is in need of great improvement. The natives of India use cattle and carabaos, the latter to a considerable extent. In the West Indies native cows are used for dairying. No particular native dairy breed of animal has been developed in either country. In India, the English tried to remedy this deficiency by importing European and American dairy animals. This undertaking, failed in spite of persistent efforts. It was found that the best breeds of milch cattle, when introduced, degenerated very quickly. The animals soon grew thin and sickly; they ceased giving large quantities of milk, and finally sickened and died.

* *Bixa orellana* Linn.

In Cuba and Porto Rico, American dairy cattle are imported to a limited extent. The dairy industry in these countries advances at a very slow pace principally because the people who handle the business do not, as a rule, possess a knowledge of modern methods of management. Many people consider that dairying as a business can not be successfully carried on in the Tropics, but R. E. Pearson, in his report on investigations in Porto Rico, states that his observations there lead him to believe that the present condition of dairying is due to neglect rather than to insuperable difficulties. He adds that great improvements could be easily and profitably made. The same may be said of dairy conditions in other tropical countries for the principal causes of their backwardness in the dairy industry are unquestionably similar.

In both India, and the West Indies, the government is now endeavoring to bring to the people the advantages of proper knowledge of the modern ways of conducting a dairy business, by giving them dairy departments in their agricultural shools, by enacting laws providing for adequate supervision and regulation of the methods of the many ignorant and unscrupulous dairymen, and by establishing local chemical laboratories where milk may be examined and regulations drafted to control the sale of milk. The educated community co-operates with the government by founding dairy associations with such objects in view as getting a reliable supply of pure milk for distribution to the general public, keeping dairy animals under sanitary conditions and preventing adulteration, and improving the quality of the milk stock by selection, crossing, and better feeding under expert supervision. This movement will not immediately result in any change in the aspect of the industry, but it will undoubtedly play a great part in putting the dairy industry in the Tropics on a firm and sound basis. This activity on the part of the government and the educated people is a decided step in the right direction. R. E. Pearson says: "It is doubtful if any kind of agriculture in the vicinity of a Porto Rican city would respond with profit as quickly and as generously as would a dairy managed intelligently and economically along modern lines." (14) It would not be assuming too much to add here that what may be done in Porto Rico could be duplicated, with little difficulty, in the vicinity of any tropical city, as the existing conditions in the Tropics are more or less the same throughout.

INTRODUCTION OF MODERN DAIRY FARMS INTO THE PHILIPPINES

The first attempt at dairying in the Islands based on modern methods was the establishment of a government dairy farm. This came about through the petitions made by the attending physician and surgeon in charge of the Civil Hospital in Manila, and by the commissioner of public health. It was claimed that the civil hospital "was running a milk bill of ₱8,000 a year and getting in return an insufficient supply of milk of unsatisfactory quality." It was also asserted that "milk was almost unobtainable by the sick, except in a few special cases through friends of the few persons who were fortunate enough to own cows, and then at a cost of 50 to 75 centavos per wine quart. The chief of the Bureau of Agriculture was therefore authorized to make a purchase of 60 high-grade Jersey cows and heifers and to establish a dairy farm." (15)

With this authority vested in him, the chief of the Bureau immediately placed an order in the United States for the necessary animals, but "in order to avoid the certainty of heavy losses

from Texas fever, he secured animals from the Texas fever belt in Mississippi. Sixty-four cows and one bull were bought for the sum of ₱7,000. They were shipped on the animal transport *Dix* and 60 of them arrived safely in Manila, after a trip of more than 10,000 miles, which occupied two months. Before their arrival, good pasture was obtained and fenced, and one of the buildings of the San Juan powder mill was converted into a fly-proof stable.

"The animals on arrival were at once given temporary serum immunity against rinderpest. No trouble from foot-and-mouth disease was experienced, nor did any rinderpest appear among these cattle until a veterinarian of the bureau of government laboratories took it upon himself without previous consultation with the superintendent of laboratories to inoculate 37 of the animals by the simultaneous method, in order to permanently immunize them against this disease. The result was disastrous, the animals displaying so high a degree of susceptibility to rinderpest that the serum failed to hold them, and all but seven died." (16)

"The survivors of this herd have kept well and have produced large quantities of milk of excellent quality, which has been used at the Civil Hospital and the Cholera Hospital (1905)." (17)

"Efforts to build up a dairy herd have been continued, and during the year (1906) 10 cows with calves, 7 yearling heifers, 11 calves, 2 to 6 weeks old, 5 young bulls, and 22 heifers, 5 months to 1 year old, have been purchased, previous experience having made it seem very probable that the best way to build up a dairy herd was to purchase young animals, which can be more safely immunized against Texas fever and rinderpest than older ones. Seven heifers from Townsville, Australia, were immunized against Texas fever on arrival and all of them were successfully immunized against rinderpest. Ten cows and calves from Sydney were not immune to Texas fever. They were inoculated against this disease with a loss of one cow, and after some losses from other causes the remaining animals were successfully immunized against rinderpest. Eleven young calves of Australian stock were purchased from a dairyman in Manila. It was necessary to feed them on canned milk. On this diet they became thin, and 3 died of gastritis. The remaining eight were successfully inoculated." (18)

"The land occupied by the dairy farm being found unsatisfactory, the government dairy was transferred to the Alabang farm on December 30, 1906, when a herd of 92 cattle was shipped to this place. (19) This farm reports that "the dairy herd has been the most important line of work maintained at this farm during the year (1907). The cattle kept in good condition while being pastured on the native pasture grasses. During a part of the dry season it has been found necessary to supplement this grass with some concentrated feed. More calves have been raised this year than last. This probably is due to better pasture conditions as well as to care." (20)

Later, after several years of experience with foreign milch cows in connection with the government dairy farm, the Bureau of Agriculture has this to say about them: "The American and Australian cattle kept at this farm have not done well in spite of the fact that they have received at all times a liberal ration of concentrated feed. The amount of milk given by the cows is about one-half what it would have been in the United States under similar circumstances. The young calves are always weak and many of them die before the weaning period ..... A sufficient length of time has been given to

this matter to settle practically once for all the question of growing pure-bred cattle from the temperate zone, and it is further recommended that no further attempt be made to grow this class of cattle." (21) The dairy herd was finally sold at public auction and with the sale of the animals the government dairy establishment practically ceased to exist.

Within the last five years two dairy establishments financed by private funds came into existence. These farms are located in the suburbs of Manila and are running under modern methods of management. Their dairy herds imported from Australia consist of Holstein, Jersey, Angus, Ayrshire, Hertford, and Durham grades. Each farm owns 26 cows and one bull.

In one farm, the animals are fed three times a day and are allowed to pasture, while the other establishment gives two feedings daily. The cows of the latter are, however, provided with sufficient grass and rice straw and are exercised in the yard. The following table will show the different feeds used, the amount of feed and the time at which it is given.

TABLE II.—RECORD OF RATIONS

	Kind of feed	*Amount in kilograms*	*Time of ration*	*Time of pasture*
Farm A (*a*)	Rice bran	5	1st ration 3:30 a. m.	5:00 a. m. to
	Copra meal	4	2nd ration 11:00 a. m.	9:30 a. m.
	Oats	16	3rd ration 4:30 p. m.	2:30 p. m. to
	Crushed food	3		4:00 p. m.
Farm B (*b*)	Grains	6	1st—morning	
	Grass and rice straw	20	2nd—afternoon	

(*a*) Amount of feed divided into three equal rations.
(*b*) Amount of feed divided into two equal rations.

During the dry season the cows in one farm are bathed twice a week and in wet weather only once. Every day, however, the lower extremities of the animals are washed as they come from the pasture, the hoofs, being particularly cleaned with a 0.3% solution of creoline. Calves are separated from their mothers as the latter enter their stalls. The other farm keeps the cows well cared for and well groomed. In both establishments the cows are washed and brushed thoroughly before each milking and the stables, milking sheds, and the surrounding premises are kept scrupulously clean. Sanitary inspectors visit the farms regularly.

These farms differed in their methods of milking at first, one using a milking machine and the other hand-milking. Recently the farm using the machine changed to the hand-milking method. Slowness of milking and the necessity of hand-milking some cows after the operation of the machine were the reasons given for the change. It is claimed that there were a number of animals in the herd that did not give all their milk by machine. At present, both farms hand-milk their cows.

Before the milking operation begins, the udders and the teats of the animals are carefully washed with hot water and thoroughly disinfected. The milkers are made to put on white uniforms and are required to wash and disinfect their hands. All the utensils used in the production of milk are thoroughly washed with soap and water and are further sterilized by steam, thus leaving no possibility for bacteria remaining. The receptacle used to receive the milk as it comes from the cow's udder is a fairly good-sized bucket tightly covered and exposing only a small screened opening. The milk in the bucket is

then transferred into a cooling cone and is allowed to remain in it for several minutes. The cooled milk is then poured into the bottling machine where it is bottled for distribution. Milk in bottles is sent to private houses, hotels, restaurants and hospitals.

The cows are bred regularly; one farm claims that six to eight months after calving are allowed to pass before a cow is bred and such animals are no longer milked. Cows that are not milked receive the usual ration. The daily output of milk is about 180 liters and the milk of all the animals is mixed in the course of milking. There is no cheese made; artificial butter-milk is sold by one farm only and the amount of this is not great. The market price per pint of milk, delivered at home, is 20 centavos. Buttermilk fetches the same price per pint. The butter fat content of the milk is estimated at about 3.25%. The milk supply of these establishments falls short of the market demand.

NATIVE MILK BY-PRODUCTS

There are two distinct native milk by-products developed in the Islands, but only one so far is considered an article of commerce—the native carabao cheese. The other milk by-product is carabao butter; this is made on certain occasions only and exclusively for home consumption.

The Laguna cheese is made from pure carabao's milk, and the cheese makers usually prefer the milk which comes from animals that have rather old calves. The carabaos are generally milked early in the morning and the milk is put in a big basin or pot where it is allowed to stand for sometime. Rennet is then added to the milk. Rennet is prepared locally by soaking the *"bahay asim"* * in whey over night. In less than an hour the curd is formed. The whey is separated from the curd by straining and the curd is salted and thoroughly mashed by hand. It is then put into the *"hulmahan,"* a wooden form about 3 inches long, 3 inches wide, and 1 inch deep, and pressed with light weights. Banana leaves are laid in the *hulmahan* before the salted curd is put into them. After a couple of hours the cheese is ready for the market. The finished cheese is wrapped in fresh banana leaves and sold in bundles of three, each bundle costing 50 centavos.

The Bulacan cheese is prepared differently. The curd is obtained by adding nipa vinegar to boiling carabao's milk. The boiling mixture of curd and whey is then poured into the *"markahan,"* a wooden form about 3 inches long, 2 inches wide, and ¾-inch thick, and pressed with light weights for 24 hours. Banana leaves with cheese cloth are placed in the *markahan*. Cheese cloth is used in the frames as strainer. The finished cheese is unwrapped and preserved in brine. This cheese sells from 18 to 20 centavos a piece. Cheese is sold in public markets and tiendas at a lower price, but this cheese is generally adulterated with rice flour.

The native butter is made from the finished cheese. The cheese is washed and ground thoroughly with a stone pestle in a big earthen vessel, using a rotary motion in the grinding. Water is then added and the fine particles that float on the water are gathered by means of clean scalded chicken feathers. The larger particles that remain at the bottom of the pot are further ground. The same process of collecting and grinding is repeated several times or until the greater portion of the original cheese has been secured. These fine particles constitute the "butter." This product is never sold in the market.

* *Bahay asim* is the spread and dried abomasum of a young ruminant, prepared at home by the native cheese makers.—*Editor.*

SUMMARY

1. Local supply does not meet the increasing demand for dairy products.

2. Dairy business in the Philippines is profitable as shown by the dairy establishments conducted in the city of Manila which have been successfully running in spite of the high price of dairy animals used.

3. Crude methods are followed in the preparation of both native cheese and native butter.

4. The carabao, which gives a good amount of milk and shows a high butter-fat content, bids fair to become a good dairy animal.

RECOMMENDATIONS

1. Dairy instruction and dairy campaigns should be conducted by government institutions.

2. Systematic breeding, looking toward the development of milch carabao should be undertaken in the Islands, either through the improvement of native animals or through importation of good dairy stock from India.

4. The native dairy animals should be given better care, better quarters and better feeding than they commonly get.

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Cross-breeding of Corn

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Thesis presented for graduation from the College of Agriculture No. 47.

INTRODUCTION

The literature thus far consulted show that no systematic work on corn crossing has ever been done in the Philippines except that reported by Mendiola, of this college. His paper reviews the history of corn crossing. In all of the works reviewed there seems to be a universal belief that crossing in corn results in an increase in yield and in vigor and to a greater or less extent in possible drought or disease resistance; "that crossing tends to create new types of the species which may show distinct improvements" (1); that when crossing is made between widely separated varieties or strains, it results in a more vigorous race, besides affording opportunities for new combinations of characters. These results are in conformity with that obtained by E. G. Montgomery (3) from an experiment on the effect of close and broad breeding on productiveness in maize. Montgomery believed that the most important result so far indicated by investigation is that all degrees of very close relationship are injurious and the yield is improved as the relationship is widened. In this connection it is pointed out, however, that this result may vary considerably with different varieties and that there should be some modifications to suit varying conditions. On the other hand, one paper of Doctor Shull (4) of the Bureau of Plant Industry, United States Department of Agriculture, reports an increase in yield following the crossing of the most closely related plants. He crossed self-and cross-pollinated ears of the same isolated strains which gave an increase in yield of 30 per cent over the parent.

An experiment made by I. Rosen (2) of Khoziaistvo in 1912 gives an interesting result, conforming with the universal basic conclusion that "the descendants of self-fertilized plants are always less developed and less productive than the descendants of plants exposed to cross-pollination." This is true of both superior individuals and individuals inferior in point of productivity, as compared with the average of the type to which they belong. The greatest diminution in the growth and yield in consequence of self-fertilization is found in the first generation, falling off gradually in the subsequent generations down to a constant value. The pure strains or self-fertilized plants coming from a single parent plant are distinguished among themselves by transmissible morphological characters. The retrogression of the fluctuating characters is observed with the greater frequency in proportion as we get further away from the mean morphological type characteristic of a pure strain. The crossing between brothers and sisters (between male and female inflorescences respectively of two coming from a single parent plant belonging to the same generation) presents no advantage over self-fertilization. Crossing between two self-fertilized strains of different types yields a progeny which is not inferior in force of growth and productivity to the plants never subjected to self-fertilization.

"In crossing two self-fertilized strains the results from the reciprocal crosses are identical. The seeds of the first generation, F_1, obtained by crossing strains according to the determined scheme (combination) always exceeds

in yield the same material produced by irregular pollination in the fields from which such generation sprang. In the second generation, F_2, of hybrids, the degree of variability is higher than the first generation, F_1. The production of F_2 is lower than that of F_1."

H. K. Hayes (5) of the Connecticut Station made a series of tests during 1912 and 1913 on the commercial value of first generation, F_1, hybrids in yield of shelled corn of several Connecticut varieties of corn grown in the same season and under uniform conditions. He worked on twenty-two varieties of yellow and white dent and yellow and white flint by using the ear-to-row method. In his study of characters he observed that red cob is dominant over white cob, colored pericarp over colorless, straight rows over irregular, light tillering over heavy tillering, and low protein content over high protein content. He noted in his results that eight crosses produced from 9.2% to 17% higher than either of the better parents.

An experiment performed by Hartley, Brown, Kyle and Zook (8) resulted in proving that not all the ears of the same variety have the same value in crossing. Some ears when crossed with another variety produce valuable hybrids and others, low-yielding strains, though, in general, there is a tendency for different ears to respond similarly to crossing. Work of this kind is attended by so many complexities that very careful tests must be made before safe advice can be given to farmers of any given locality as to the greater advantage of continuing to plant the original pure strain. East (7) crossed *Nicotiana tabacum* with *N. alata*, and the resulting cross was decidedly inferior, the best individual being only one-fourth as large as either of the parents. We therefore have reason to believe that species vary in their ability to successfully cross with other species or varieties.

A recent experiment (6) performed by the United States Department of Agriculture on the cross-pollination of Indian corn proved that crossing two varieties of maize is followed by an increase in the size of kernels in the immediate progeny. Eleven carefully conducted tests showed an increase in yield ranging from 3% to 21%, which result is accounted for simply as a xenia effect.

OBJECT

As noted in the foregoing discussion, results in almost all cases tend to show that crossing, if judiciously done, produces an increase in yield without requiring additional ground space or an extra amount of seeds, by improving the individual performance of the plants.

Such results are unquestionably of universal application. It is the purpose of the present work to determine the practicability of applying this method to the conditions existing in this locality. In a series of experiments conducted in this college, Mendiola (1) proved that wide crosses gave a considerable amount of advantage over close-fertilized ones. He used dent and flint varieties of different colors as parental stocks, the hybrids of which, of course, produced ears of mixed colors, which are always of a lower market price, as compared with one-colored strains.

The present study has the object of determining the best way of obtaining a uniformly colored cross, as well as a more uniform seed strain, which will command a higher price because of its uniformity and still show all the improvements produced from cross-fertilization. It was planned to accomplish this by crossing strains within certain general types, as dent with dent and flint with flint.

In this study no attempt is made to measure the effects of cross-fertilization by results obtained from other factors which might slightly influence the yield, such as detasselling. Experiments in the United States in detasseling show widely contradictory results. Experiments in the Nebraska Station (9) gave 528 pounds of corn from 10 detasseled rows, 1,220 pounds from 10 normal rows alternated with the detasseled rows and 2,369 pounds from 20 normal rows elsewhere in the field. At the Kansas Station the results were also decidedly against detasseling. On plots from which the tassels were removed from alternate rows the yield was 114.55 pounds and from rows with tassels 185.75 pounds. Again, the Illinois Station believes that if detasseling is beneficial at all, it must be so on poor soil or in dry seasons. The Cornell Station obtained some apparently favorable results but these were widely variable. It seems evident that no exact work on detasseling can be done without first isolating pure biotypes which shall be quite immune to unfavorable effects from inbreeding, and Hayes, of Minnesota, has shown that it takes five to six years to accomplish this.

VARIETIES USED IN THE PRESENT EXPERIMENT

The parent types of maize used in the present experiment have not been previously inbred by hand, a procedure which is quite indispensable in obtaining accurate results. They were simply obtained as good seed corn, some from the Bureau of Agriculture and others from local growers. Most of the varieties were not grown in the same locality. Each lot, however, represents a reasonably pure strain.

Hartley in his paper (8) says, "It is to be noted that the most profitable varieties for given localities will often be varieties that have not been cross-bred or mixed with other varieties for many years and their merits are largely the results of selection, acclimatization and adaptation".

The following table contains the parental stocks:

TABLE I

No. of crosses	*Female parent*	*Male parent*	*Cross strains*
I	$357F_2$	$1490F_1$	($357F_2$ × $1490F_1$)
II	2581	$2298F_1$	(2581 × $2298F_1$)
III	2802	$184F_4$	(2802 × $184F_4$)
IV	3149	3150	(3149 × 3150)
V	3163	3149	(3163 × 3149)

The following is a description of each of the parental stocks that furnished the materials for the present experiment: The First Prize Mestizo, $357F_2$, has been grown in the college for two generations. It is one of the best varieties, if not the best, of the white dent in the college. It is flinty, though it contains a fair amount of starch.

The Iowa Ideal is a white dent corn also having gluten and starch almost equal in amount. It is one of the best varieties of corn in Iowa State. Before this corn was used, it had passed through one culture at this college. It bears the college number $1490F_1$.

The White Flint Moro, 2581, was obtained from the Bureau of Agriculture. This has shallow kernels borne on a comparatively large cob.

The Pasig White Flint, 2298, is a small-sized strain of corn with shallow kernels and with a proportionally large-sized cob. It was received from Mr. Velasquez. Before it was used in the experiment, it had passed through one culture at the college.

The Pasig Yellow Flint, 2802, is a variety of medium-sized corn. It was procured from Pasig the same year that the present experiment was begun.

The Old College Yellow Flint, $184F_4$, was grown through four generations

before this experiment. It is a common type of native corn, with a distinct tendency to tapering ears. It is of medium size, with shallow kernels and with a comparatively large cob.

The Bay Moro White Flint, 3149, is a flinty white variety of corn. It is of good size with shallow kernels and big cobs. It was pruchased from local dealers in Bay, Laguna.

The Native Yellow Flint, 3150, is of recent introduction into the college, from the neighboring barrio of San Antonio. It is of good size with kernels shallowly set in the cob with a big cob having a tendency to taper.

The Pure Moro White Flint, 3163, has a big cob, shallow kernels and has a tendency to taper.

METHODS IN THE PRESENT EXPERIMENT

The preparation of the land was undertaken by the Department of Agronomy. Practically no artificial manuring was done. During the course of the experiment, cultivation was maintained at its usual high state.

As in common practice, cross-pollination was secured by planting in alternative rows, detasseling the variety intended for the female parent, leaving the other to produce tassels that would bear the pollen for the fertilization of the ears of the detasselled rows. In the male parent rows, the barren and weak plants were detasseled or destroyed completely to prevent the spread of undesirable characters.

The following table contains the different crosses secured showing the dates of planting, germination, tasseling, silking, and harvesting:

TABLE II

Cross No.	*Planting 1914*	*Germination (1914)*	*Tasseling (1914)*	*Silking (1914)*	*Harvesting (1914)*
I	April 23	April 28	June 1-15	June 11 to June 21	July 25 to Aug. 8, 1914
II(a)	April 25	April 29	June 11-21	.....	.....
III	April 25	May 1st	June 12-24	June 19-30	July 25 to Aug. 8, 1914
IV	Oct. 7	Oct. 10	Nov. 22 to Dec. 7	Dec. 3 to Dec. 13	Jan. 14-15, 1915
V	Oct. 21	Oct. 25	Dec. 10-25	Dec. 15-28	Jan. 28-30, 1915.

(*a*) Cross II was a complete failure because only one ear was available for the experiment and adverse conditions prevailed at this time, several replantings having been necessary and thus flowering did not come at the right time to obtain results as expected.

FIRST CROP

From the detasseled, as well as from tasseled plants, ten to fifteen ears were selected. The following results were obtained:

In all cases, uniformity in color, as well as in type, is exhibited. Crosses I, III and V, having as their parents strains of the same color (white), proved to be a pure-colored type. Aside from other advantages resulting from crossing, the product possesses characters that enable quick and profitable marketing because of uniformity. It, however, appears that the average weight of an ear in the case of Crosses I and III is somewhat lower than that of either of the parent stock. The reason for this is that there was prolonged drought while growing the crosses. In fact, some watering was necessary to enable the plants to survive. This condition obtained for several weeks until finally a storm broke out. The appearance of swarms of migratory locusts at about this time resulted in an almost complete destruction of the leaves. In spite of these adverse conditions, however, fair final results were obtained.

In the case of Cross IV, a cross between two strains possessing different colors, one white and the other yellow, the product obtained is of utmost interest and value. The result is a crea-

tion of a uniform type very different from either of the parents in shape, color, and many other characteristics.

In the case of Cross V, which is a cross between two white flints, the crop obtained, like Cross IV, is of great value, due to its uniformity in type and in grade.

a. Progeny from Cross I.

Judging from the characters exhibited by the progeny of Cross I, it appears that not much advantage is obtained over its parents. It is simply intermediate between the parents used; the fact that the actual weight of an individual ear of the parents (male and female) is larger than that which is finally obtained does not necessarily show that the crossed strain, is a poor yielder, for an actual weighing shows that in the case of the crossed strain, reducing the yield to terms per hectare, gives 2,463.04 kilograms (*a*) of husked corn, while in the case of the male parent it gives only 2,175.6 kilograms per hectare. It will also be noted that when comparison is made between the strains originally used and the succeeding crossed one, the latter is smaller, since this crop, as above stated, suffered severely from adverse conditions, while the former were grown under favorable conditions; but if comparison be made between the same season crops, all conditions being equal, it would appear that advantage is shown by the crossed strain.

b. Progeny from Cross III.

As this was grown at nearly the same time and at the same season as Cross I, and planted in a field adjacent to it, the results obtained in both cases were somewhat similar but the former was characterized by an increase in the amount of kernel in the average individual ear, and by a consequent proportionate decrease of the weight of the cob.

c. Progeny from Cross IV.

Unlike other crosses that came under observation, this particular cross displayed a very interesting and notable result. It attained perfect uniformity in type, as well as in color, and in fact, those who have seen the crossed strain side by side with the male and the female parents, noted in it a new kind of corn. It came perfectly pure without any of the usual xenia effects following the crossing of very distinct corns. Its color approached bright, clear lemon yellow. This was a cross between native yellow flint and white flint Bay Moro. As to size of grains and the consequent weight of individual ears, as well as other important characters, the crossed strain showed a great gain. This result is in conformity with that obtained in an experiment (6) conducted by the United States Department of Agriculture on cross-pollination of Indian corn, which resulted in the immediate gain in weight of 3.21%. This fact is further corroborated by the results of the present experiment. Actual weighings were made of the crossed strain and of the male parent from given plots. From the male parent only 132.0 kilograms of husked ears were obtained; from the female parent, only 33.55 kilograms; and from the crossed strains, 168.2 kilograms each, harvested from an area of 500 square meters of ground. Reducing to bushels per acre, the male parent yielded 37.7 bushels, that from the crossed strain, 48.05 bushels per

(a) 31.81 kilograms of husked ears of corn make a bushel.

acre. The yield of the female parent need not enter into calculation for it is very low due to the attack of the downy mildew (*Sclerospora maydis*), a disease very recently reported from India by Butler and now known to be widely distributed in the Philippines.

d. Progeny from Cross V.

This is a cross between a White Flint Bay Moro and White Flint Southern Islands Moro. This cross, like Cross IV, proved to be a valuable strain being superior to either parent in almost all important characters. In uniformity of product it gave as good a result.

SECOND CROP

It was only from Crosses I and III that attempt was made for testing the second generation product. From ten to fifteen desirable ears were selected for the second crop planting and these were planted on September 26 to 29, 1914, in a patch of ground formerly used by the Department of Animal Husbandry. After they had shown a very promising start a week after they were planted, they were entirely destroyed by the downy mildew.

The following table will enable one to make a comparison between crossed strains or hybrids on the one hand and male or female parents on the other.

College No.	No. plants per hectare	Ears per plant		Average height per plant meters
		Fertile	Sterile	
$1490F_2$	26,666	0.9	1.0	1.84
($1490F_2$ x $357F_2$)	26,666	1.1	1.0	1.98
$184F_4$	26,666	0.8	0.7	1.70
$2802F_1$	26,666	1.03	0.7	1.76
($184F_4$ x 2802)	26,666	0.98	0.8	1.90
$3150F_1$	26,666	0.84	0.71	1.93
$3149F_1$	26,666	1.0	0.99	1.96
(3150 x 3149)	26,666	0.93	0.81	2.05
3149	26,666	1.0	0.99	1.96
(3163 x 3149)	26,666	1.0	1.0	2.00

(*a*). In finding the number of plants per hectare, the number of plants per hill, distance between the hills, and distance between the rows are considered.

Fertile and sterile ears are computed from an actual count of from 100 to 400 plants.

The Moro corn, which the Bureau of Agriculture introduced widely all over the Islands, rarely has done as well anywhere else as it does in their home in the Southern Islands. The behavior of the Moro corn grown in Pasig and at the College of Agriculture during the previous years indicates that careful acclimatization and continued selection is necessary before it could compare with the southern product. However, some valuable results were obtained from one of these strains in the present experiments. It would be of interest to repeat this work where Moro corn does its best.

In order that the conclusion arrived at can readily be traced the following summary table will be necessary. It is here that the averages of the parents (male and female) and crossed strains or hybrids are summarized.

SUMMARY TABLE

CROSS I

Variety names Coll. No.	Ear			Row		Kernel				Cob		Percentage of	
	Weight in grams.	Length in millimeters.	Diameter in millimeters.	Number.	Kernel	Weight of 100 in grams.	Length in millimeters.	Width in millimeters.	Thickness in millimeters.	Wt. in grams.	Diam. in millimeters.	Cob	Kernel
												%	%
Male Parent $1490F_2$	156.3	170	43.9	16	39.4	25.1	10.6	8.5	4.3	22.8	25.3	14.6	85.4
Female Parent $357F_2$	222.45	172.8	49.4	16	39.0	31.8	14.0	8.9	4.1	34.3	30.75	15.3	84.7
Hybrid ($1490F_1 \times 357F_2$)	158.9	150.2	40.4	14	36.5	27.2	10.6	8.9	3.7	23.3	27.0	14.6	85.4
CROSS III													
Male Parent $184F_5$	123.5	147.0	40.4	14	33.9	23.5	8.7	8.3	4.2	17.3	26.4	14.0	86
Female Parent $2802F_1$	159.4	192.0	40.1	14	38.5	28.0	9.1	8.6	4.4	22.5	26.7	14.1	85.9
Hybrid ($184F_4 \times 2802$)	130.8	163.0	40.7	14	36.1	24.3	8.60	8.3	4.2	15.8	25.9	12.1	87.9

SUMMARY TABLE.—*Continued*

Variety names Coll. No.	*Ear*			*Row*		*Kernel*					*Cob*		*Percentage of*	
	Weight in grams.	*Length in millimeters*	*Diameter in millimeters*	*Number*	*Kernel*	*Weight of 100 in grams.*	*Length in millimeters*	*Width in millimeters*	*Thickness in millimeters*	*Wt. in grams.*	*Diam. in millimeters*	*Cob*	*Kernel*
CROSS IV													
Male Parent 3150F_1	172.2	183.0	43.8	12	39.0	28.5	9.8	8.6	4.4	26.8	28.3	15.5	84.5
Female Parent 3149F_1	190.0	166.7	48.6	14	34.7	29.1	9.27	9.05	4.47	39.5	33.6	20.7	79.3
Hybrid 3150×3149	236.2	176.7	48.5	14	35.5	34.1	10.2	9.2	4.6	50.1	33.9	21.2	78.8
CROSS V													
Male Parent 3149F_1	178.9	174.7	45.7	14	35.2	27.4	8.8	9.8	4.2	42.4	33.4	23.6	76.4
Female Parent 3163	208.6	181.0	48.7	16	36.7	30.0	9.8	9.8	4.5	43.2	33.6	20.7	79.3
Hybrid 3149×3163	229.1	181.0	49.8	14	37.0	32.2	9.3	9.4	4.59	46.9	35.5	20.5	79.5

(*a*) The foregoing summary table is a digest of over ten long tables which embody in detail the results of Mr. Marquez's experiments. They were left out in printing because it was not practicable to include them in this publication.—Ed.

GENERAL RESULTS

Cross I.

In an actual weighing of the male parent and the crossed strain produced from a given plot, as explained in the previous pages, the latter excels the former by 11.7%, which is equivalent to 4.09 bushels of husked corn per acre.

Cross III.

The crossed strain exceeds the male parent in weight as in other characters. In the amount of grains per ear it exceeds the average of the two parents by 2.0%.

Cross IV.

Actual weighings of parents (male and female) and first crosses show that the latter gained in weight over the male parent by 21.5% equivalent to 10.3 bushels per acre of husked corn. In all other characters the first cross exceeds either parent.

Cross V.

The crossed strain exceeds the parents by 15.4%, amounting to a gain of 13.4 bushels of husked corn per acre.

PRACTICAL SUGGESTIONS

For the guidance of inexperienced farmers who may care to try cross-breeding work, the following suggestions are given:

1. Especially valuable strains of corn can be kept pure by planting in an isolated place.

2. Crossings should be made between pure strains within certain general types, preventing as far as possible the access of foreign blood. This will tend to produce a uniform product.

3. If a foreign variety is used in the cross with a local variety, it would be preferrable to use the former as the male parent.

CONCLUSIONS

1. Considerable gain is possible in first-generation crosses of closely related strains.

2. The crop produced in (1) has in our experiments proved always reasonably uniform in grade, when closely related, but distinct strains were used.

3. The hybrid seed may be of great value for commercial planting, if closely related strains are used.

4. Wide crossing corn only leads to undesirable xenia effects, but occasionally in expert hands, to the creation of new types which can only be separated and fixed by careful selection and ear-to-row cultures, though sometimes even here, as in our Cross V, a first generation result of great uniformity and value may be obtained.

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